AMATEUR SATELLITE REPORT

AMSAT's Newsletter for the Amateur Space Program.

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(See the last page for details)

AO-10: The First Two Weeks

The hopes and dreams of radio amateurs world-wide were advanced recently when on the morning of 16 June, a new OSCAR, the most advanced amateur spacecraft ever conceived, was successfully launched into orbit.

The scene might have come from the pages from a Hollywood script. Barely three years after a tragic end to the Phase IIIA bird, Phase IIIB became AMSAT OSCAR 10 on 16 June. All who listened to the ALINS (AMSAT Launch Information Network/Service) realized at that instant that a page in amateur radio history had been turned. And pride in the completion of this critical phase — getting to orbit — swelled in tens of thousands. AMSAT President Tom Clark, W3IWI, speaking on ALINS from his remote Mohave Desert (California) temporary NASA work station, was especially proud at having reached the milestone. It was W3IWI who rallied the team together after Black Friday, 23 May 1980, when Ariane LO-2 and Phase IIIA became the world's most famous rocket-powered submarine! Now, however, the joy of thousands was crystalized in images of Ariane L6 parting the clouds easily, triumphantly, and gracefully placing ECS-1 and moments later Phase IIIB successfully into orbit.

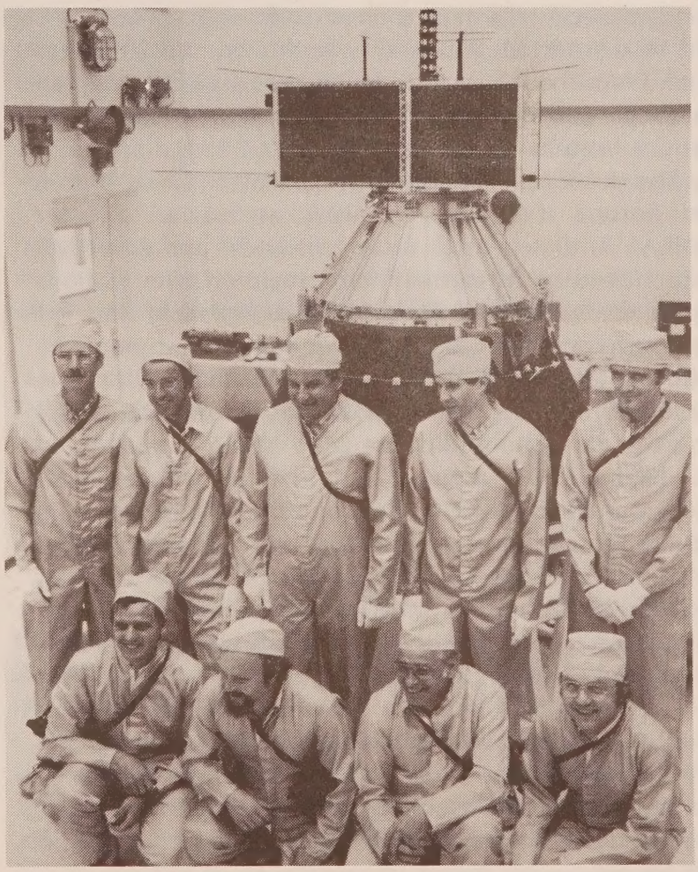
Here's a summary of the events leading up to launch and the first two weeks after launch.

The launch date of 16 June had been holding steady for about a month. A slip from 3 June had been preceded by a slip from May. When the Phase IIIB launch support teams from Germany, South Africa and the U.S. returned home leaving a skeleton caretaker crew at the launch site, it was hoped the 16 June date would hold. It did.

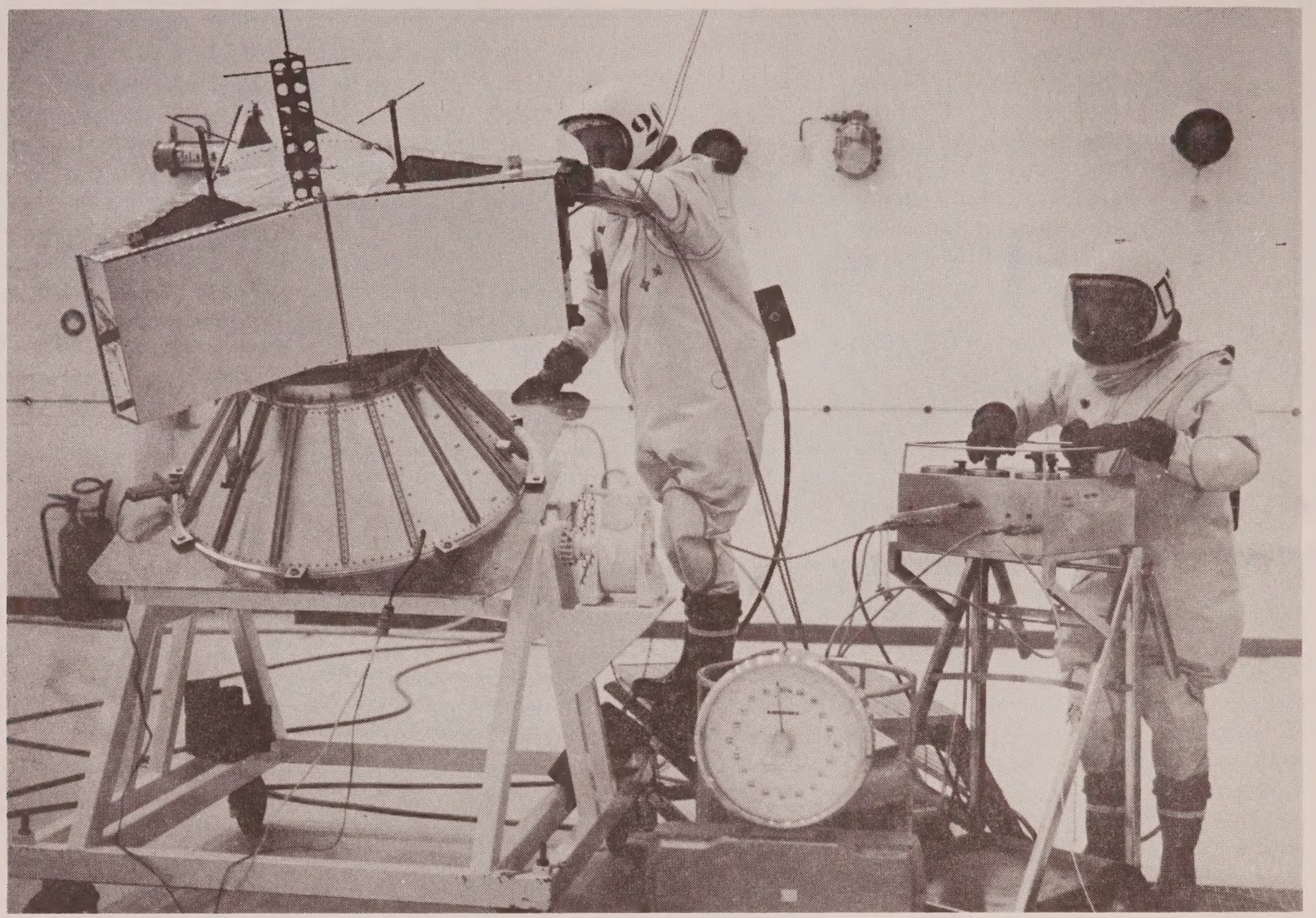
Dawn at the launch site at Kourou, French Guiana, was much the same as many steamy mornings. In the tropics (Kourou is within 5 degrees of the equator), seasons aren't easily discerned. The threat of bad weather, moreover, had not materialized. Launch time was set for 11:59 UTC, the opening of a 90 minute launch window.

The countdown at Kourou proceeded well with no glitches. Meanwhile, tens of thousands of listeners around the world consciously or otherwise leaned slightly closer to their radios, the better to hear the countdown procedure. The ALINS superbly organized by WØRPK and K1HTV went virtually perfectly. Some propagation deficiencies to the South Pacific and elsewhere were later noted but for the most part ALINS effectively blanketed the world. HF stations W1AW, W3TIA, WØRPK, NØAN, AIØZ, WA6GFY, W6VIO, W3OZ, G3AAJ, G3RWL, KH6SP, KH6GMP, and others provided live coverage from 160 through 2 meters. Dozens of other secondary ad hoc relay points sprang up around the world too.

Center of the network was located at the AMSAT Ground Command Center (GCC) at NASA's Goddard Space Flight Center, Greenbelt, Maryland. From there both landline and rf links connected to hf and vhf relay stations. For example, the lab transmitted on 2 meters to the AMSAT repeater, W3ZM. WA3TIA in the Washington, D.C. area picked up the 2 meter input leg



The launch support crew. Upper: W4PUJ, DK4VW, DJ5KQ, W3GEY, ZS1FE. Lower: W. Gladisch, W. Mueller, K. Mueller, DJ4ZC.



Loading the highly toxic propellants. Left W. Mueller; right W4PUJ.

and retransmitted the quality audio on the 20 meter band. From the lab a landline link was established to an American Bell conference bridge in New Jersey. Relay stations from as far east as England (G3AAJ) dialed into the bridge for ALINS audio to retransmit to Great Britain and Europe. From as far west as Hawaii another (WH6AMX) dialed in to relay to KH6SP and KH6GMP who relayed on hf to the Pacific region. Other stations across the nation did likewise for assigned hf and vhf coverage zones. WA2LQQ provided the narration of the action interspersing background information on the spacecraft and launcher with the countdown status and progress. An open audio line from NASA (Goddard) to ESA (Kourou) was monitored at the lab and provided background audio to Rip's account. KB2M sat at the controls of the audio mixer panel providing superb control of the complex interfacing and mixing that was required between multiple ports. K1HTV applied his expertise to lashing the system together at the lab while system architectural control had been established by WØRPK. Thus, the world of amateur radio could follow in real-time the unfolding events that mid-June morning.

Then all knew the final moments were here. Much as the approach of a diesel locomotive racing toward you, you knew that the moment of truth was at hand. Would you be hit by the train? The enormity of the moment grew as the mental second hand swept through its final arc...as another mental second hand swept through major milestones leading to this moment: Black Friday...L5 lost...Shake and bake tests complete...more. Now the story would be told. Ten, 9, 8...WA2LQQ's voice-over the ESA controller spoke the words all had waited to hear. Five, 4, 3, 2, 1. Hearts stopped. Or exploded in tension. The next words heard, "Ignition" signaled the beginning. Or was it the end? Then, "Liftoff. We have liftoff." We were on our way!

With enviable precision the Ariane L6 launcher ticked off according to the timeline. *ASR* readers followed the script second by second. The minutes sped by now. Launch time was announced as 11:59:03.360 UTC 16 June. Then it was time for ECS-1 to be deployed. At 12:14:55.051 it became a new earth satellite. But what about Phase IIIB? Again the tension grew. Moments later it was done! At 12:16:53 UTC, AMSAT OSCAR 10 was born! The Phase III era had begun!

We were in orbit! Next all wondered if AO-10 had survived the ride. Would the telemetry beacons turn on when scheduled two and a half hours later? ALINS was shut down after a few minutes of recap and reminders of follow-on, post-launch ALINS.

By 14:45 those at the lab knew the Mode B beacon should be on. Moments ticked by while all waited for the phone to ring; waited for reports from the Pacific region that AO-10 was alive and talking. Mercifully the phone rang at about 14:55 UTC. It was Ian, ZL1AOX. He said the he and a dozen or so of his colleagues in New Zealand

had all heard AO-10 when it first came on at about 14:45 UTC. Later it was learned that JR1SWB, JA1ANG and dozens of their colleagues had heard AO-10 as well at the exact moment of Mode B beacon activation. AMSAT OSCAR 10 was alive and talking!

Soon stations around the world were reporting reception of the beacon on 145.81 MHz. Joy prevailed.

Then some bad news. Initial telemetry frames analyzed by the Ground Command Stations (GCS) indicated a poor sun angle. Somehow the attitude of AO-10 was wrong. Without some remedial measures AO-10 could be in serious thermal and electrical troubles soon. DJ4ZC promptly commanded the beacons to a 1/3 duty cycle (20 minutes on, 40 minutes off per hour) to reduce power consumption. The solar panels were being illuminated at only a very shallow angle (estimated at about 15 to 20 degrees). That meant less energy to run the satellite. It also meant the spacecraft would be running colder than designed. In some locations it would be frozen down to −20 degrees C or colder. This was cause for serious concern since the propellants, if cooled to that temperature, could freeze solid with potentially catastrophic consequences. However, the move to reduce power consumption was effective. The net power budget remained positive so there was small risk of battery depletion given a stable situation. That gave some time for analysis and for a solution to be worked out.

Within a day or two it became evident that the major danger had been passed and that there were natural forces at work that would help remedy the incorrect sun angle with little or no outside intervention. Although some discussion of using the magnetorquers for reorientation had transpired, it was considered too risky to use the torquers at this point. With no sun-reference for the sun-sensors, no timing reference could be attained for pulsing the magnetorquers. Beyond that, the amount of power available combined with the ineffectiveness of the torquers at this attitude spoke against their employment for the moment.

Within a week it had been ascertained that the improvement in sun angle amounted to between 3 and 4 degrees per day. When the sun angle had been improved by about 30 degrees, the sun sensors would begin to pick up the impulses that were needed to synchronize the magnetorquer pulsing. The sun sensors have a range of ±45 degrees. So it appeared a waiting period of between 10 days and two weeks was the best option. The "helpful" forces that were operating on the spacecraft appeared to be three-fold:

a) The natural movement of the earth and its satellites around the sun (seasonal movement amounting to about 1 degree per day)

b) Atmospheric drag

c) Induced magnetic fields in the spacecraft caused by Eddy currents themselves results from the passage of a conductor (AO-10) through the geomagnetic field.

These effects accounted for most, if not all, of the observed improvement in the sun angle as seen from AO-10.

Things were improving and hopes were buoyed by the happy prospects that lay ahead. Then a big surprise! By a week after launch, while analysing the sequence of illumination of the solar panels in an effort to determine attitude and spin in the absence of the solar sensors, it was discovered that the spacecraft was not only *not* spinning as fast as it should have been...it was spinning in the wrong direction! And at only 2.5 RPM!

In the week subsequent to launch much speculation and theorizing had transpired in an attempt to explain the poor sun angle attained immediately upon deployment from the Sylda (the launcher cannister). All manner of suggestions appeared from silly to erudite...some brilliant even. None seemed satisfactory in that each explained only some of the symptoms and often appealed to some highly unlikely event or phenomemon as its key feature. One theory postulated an anomalous fuel-sloshing or turbulance in the tanks. Another version said that the fuel had partially frozen leading to a serious imbalance. And so forth. Finally, KA9Q postulated that the fundamental cause of the poor sun angle had more to do with spin rate at deployment than any exotic effect of fuel turbulance or freezing. His theory is widely accepted now because it explains many of the symptons and requires only a simple malfunction to generate to observed effects. The cause of the hypothetical malfunction is now the subject of close scrutiny in Europe and the U.S.

Meanwhile, the spacecraft continued to spin down until by Friday, 24 June its angular velocity was down to a slow 1.6 RPM. It had been designed to spin at 10 RPM at this stage. The spacecraft obtains its stability in orbit by spinning; it's simple and inexpensive to stabilize that way. The magnetoquers are used not for stationkeeping but rather for orientation changes. But when the spinning stops or slows, just as with a toy top or gyro, stability is lost and undesireable motions such as precession and nutation can occur. So when AO-10 reached 1.6 RPM, it was clear action was required.

So on the evening of 24 June (25 June UTC) software instructions previously up-loaded by DJ4ZC to AO-10 were executed by the IHU (Integrated Housekeeping Unit; the computer on AO-10). The first session of magnetorquing was under way. The result was highly successful and the spacecraft's angular velocity (spin rate) was increased to about 6 RPM. The cw telemetry "Spin" parameter was found to be in error because, as a result of the "backward" spin and the low sun angle, the IHU was "unsure" of the actual spin rate. But more time had been bought. Most important of all, the spin up had also included a re-orientation maneuver. The latter had vastly improved the sun angle; it was now very nearly perfect. Later, the Mode B beacon was placed on 100% duty cycle. The cw telemetry showed the improved sun angle had helped further warm AO-10 too. Occasionally the temperatures would rise to close to 10 degrees C; downright cozy compared to the frigid temps it had seen the week earlier!

Then early on 30 June UTC the next spin up maneuver was performed. As before on 25 June UTC there was no attempt to spin down from the negative direction to a positive direction (the "right" way) since there is no inherent preference of the spacecraft for either spin direction. The software can be adapted easily. There IS, however, a strong desire to avoid the low-rev regime (low

spin rates) since there is the possibility of instability (wobble) at the low spin rates. Thus from the initial −2.5 RPM or so at deployment to the −1.6 on 25 June, we accelerated to −7 RPM and on 30 June to −18. Precision measurements made by WA2LQQ and K1HTV on 30 June established the spin rate then (0320 UTC) at 18.68 ±0.01 RPM. These precision measurements were made by noting the nulls and peaks of the antenna pattern swept across the receive site by the spinning spacecraft. Long strip chart recordings and precise time increment measurements led to the result. On Thursday, 30 June, DJ4ZC indicated the command team would likely strive for "about 40 RPM" prior to the first kick motor firing.

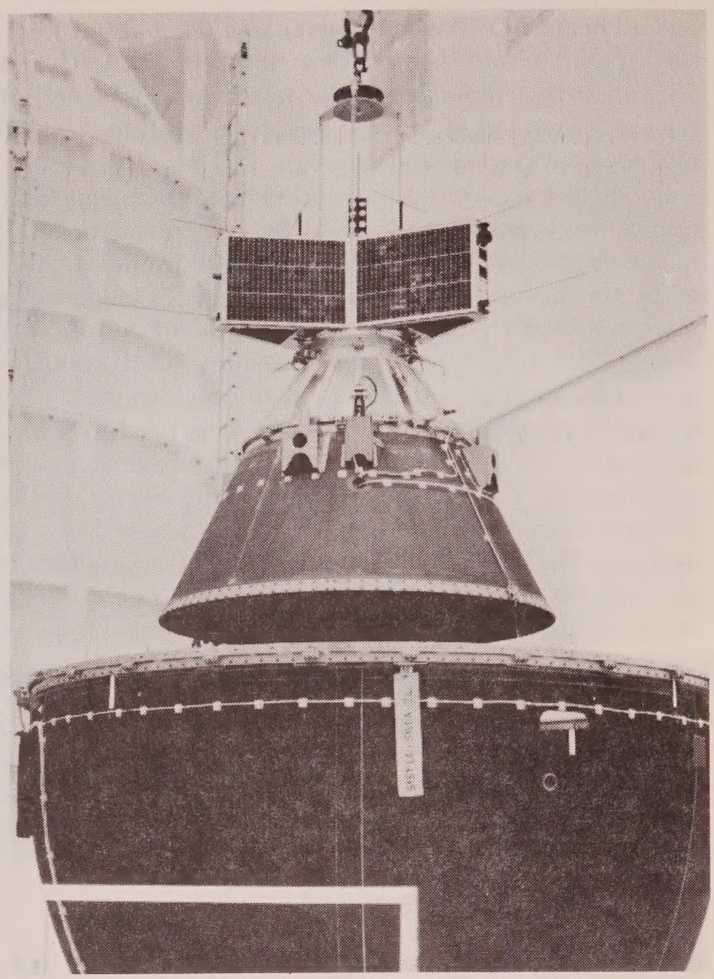
At press time the best estimate of the date of kick motor firing is 5 to 7 July. Additional spin up and reorientation maneuvers were to be accomplished over the Fourth of July Weekend.

AMSAT OSCAR 10 contains a small rocket engine designed to boost it from its initial orbit to one that is better for its intended purpose: Amateur Radio communications. The low inclination and low perigee (low point) of the initial "transfer ellipse orbit" have some severe limitations. First, with a low inclination, it does not serve well those in latitudes distant from the equator; further than about N 45 or S 45 it's always very low on the horizon since the maximum latitude it travels from the equator is the same as the inclination of the orbit. Right now, AO-10's orbit is inclined 8 degrees. Later it will be increased to 57 or 58 degrees. With the low perigee, moreover, the orbital lifetime is limited to a few months or so. So there are good reasons to boost to a new orbit.

AMSAT OSCAR 10 will be boosted to its final orbit in two steps. The first step will raise the perigee to perhaps 1000-1500 km from its initial 200 km and simultaneously raise the inclination to 10 to 15 degrees. (Many of the variables affecting the PRECISE values to be sought are being analysed and optimized now, so the exact values are not yet set.) The first burn of the liquid fuel, apogee kick motor will last between 35 and 45 seconds and consume about 15% on the propellants: N_2O_2 (nitrogen tetroxide) and UDMH (unsymmetrical di-methyl hydrazine). The second burn will take place within about two weeks and burn the remaining fuel to depletion. The second burn will raise the perigee slightly and the inclination a great deal. It is hoped that the inclination can be raised to about 58 degrees. The exact value attained will depend on a host of factors including the efficiency of the motor and the mass of the spacecraft, the precision of the firing attitude and so forth.

The second motor firing may occur in mid-July. If it does, the initial transponder use by the general Amateur Radio community can be expected shortly thereafter; perhaps within a few days. So mid-July is the best guess on when the doors will be open. This is, of course, subject to the successful, timely completion of those several tasks remaining.

Until the transponders are available for general use as announced by AMSAT HQ, the transponders should not be used. If you hear them on, resist the temptation to kerchunk the passband. Chances are that you'll interfere with ranging tests and your kerchunk may pollute the data necessary to measure the orbit precisely.



Depositing Phase IIIB in the SYLDA.

At press time the best orbital information was coming through informal channels rather than the formal NASA Goddard source. The problem is that this object (AO-10) is small (low radar cross-section) and is in deep space. It is thus difficult to track over the short term. In fact, the initial NASA "predicts" appear to be for the wrong object. The catalog number for AO-10 is 14129 but another object has apparently been mistaken for AO-10 and information disseminated on the spurious object in place of AO-10. For now, the best elements available are those included elsewhere in this issue.

The first two weeks in the life of AO-10 have been exciting, albeit occasionally worrisome. The spacecraft has proven to be superb in every sense. Even when operated substantially outside of its design envelope, it has recovered perfectly. It is truly a magnificent machine worthy of the pride a million amateurs world-wide now feel in their newest, most advanced OSCAR.

Annual Meeting Scheduled

This year's Annual Meeting is being announced early in anticipation of a large turnout. Jack Colson, W3OZ, has made special arrangements with the Applied Physics Laboratory of the Johns Hopkins University to accommodate this year's event. The meeting will be held November 12 in Laurel, Maryland just outside of Washington, D.C. If you plan to attend this year's Annual Meeting, please alert Martha at AMSAT HQ so she can save a spot for you.

Space Research Conference Slated

A conference on "Private Sector Space Research and Exploration" is a specialized conference designed to bring together organizations interested in furthering non-governmental research in space. The conference is sponsored by the Independent Space Research Group, Inc., Troy, New York. The ISRG aims to build an Amateur Space Telescope (AST) and have it orbited by a cooperating authority in the future.

The ISRG-sponsored conference will be held August 4-7 at the Cocoa Beach Holiday Inn, Cocoa Beach, Florida. The meeting is timed to coincide with the first night space shuttle launch, STS-8, tentatively scheduled for 4 August.

ISRG says the purpose of the conference, the first of its kind, is to "share information and discuss matters of mutual interest." According to the press announcement, "The following organizations have expressed interest in participating in the conference: World Space Foundation, University of Surrey, AMSAT, Union des Promteurs de Propulsion Photonique, and ISRG. Other invited participants: AIAA [American Institute of Aeronautics and Astronautics], AMSAT France, British Interplanetary Society, CEROS, JAMSAT, The Space Studies Institute."

Advance registration for the conference is $25 payable to ISRG and covers all conference activities including transportation to and from the Cape for STS-8 launch, copies of conference abstracts and proceedings. Guests are to make their own accommodation arrangements. Room rates at the Holiday Inn where the conference is to be held are $45 single or double. Telephone 305-783-2271. Address is 1300 N. Atlantic Avenue, Cocoa Beach, FL 32931. Mention that you are with the ISRG Space Conference for access to the reserved block of rooms.

For further information, contact ISRG at P.O. Box 1246, Troy, NY 12190.

Call For Nominations

AMSAT HQ announces that nominations for Director are now in order. There are seven Directors and two alternates on AMSAT's Board of Directors. Directors are elected for two year terms. Four seats are up for election in odd-numbered years; three in even-numbered years.

Nominating petitions shall contain the name of the nominated AMSAT member who agrees to serve if elected and the names and signatures of at least five members in good standing who nominate the individual. An authorized officer of a member Society may also nominate. Nominees are expected to provide biographical information.

Nominations shall be sent to AMSAT, P.O. Box 27, Washington, DC 20044 to arrive no later than 22 Aug. 83.

Seats up for election in this cycle include those of Mssrs. Browning (W6SP), King (W3GEY), Zwirko (K1HTV) and Henry (VE2VQ). The four nominees receiving the most votes shall be elected Director. The nominees receiving the fifth and sixth highest total votes shall be elected First and Second Alternate Director, respectively.

Seek Net Control Stations

With the departure of one of its Net Control Stations (NCS), AMSAT is in need of at least two additional HF NCS. Bob Nickels, KEØT, is relocating and cannot continue his former role as NCS. Consequently Net Manager W8GQW has issued an urgent appeal for NCS's to serve the Sunday AMSAT International Nets.

The AMSAT International Nets meet on Sunday at 1800 UTC (21.280 MHz) and 1900 UTC (14.282 MHz) weekly. The remaining team, N3AR, KO5I and W8GQW require at least two additional team members in order to maintain the desired once-per-month rotation with a back-up for personal contingencies, etc.

Basic requirements to become an AMSAT NCS are having a competitive signal on 20 and 15 (suggested 1200-2000 watts PEP, good tri-band beam at 40' or above), a reasonably good speaking voice and the willingness to spend some time preparing bulletin material. News items, bulletins and other information are provided from AMSAT HQ. This is a challenging, responsible position for which an understanding of and deep committment to the ideals of AMSAT's mission and purpose is essential.

AMSAT President Tom Clark, W3IWI, has called the AMSAT Nets "Our primary communication element in the field organization."

AMSAT President Elect, Rip, WA2LQQ, says: "AMSAT's HF Nets will always be essential in getting new people aboard the satellite program. It is here (on the HF bands) we find our new members and point them in the right direction. We absolutely require competent, highly motivated people out front with the HF Nets. Without them, we have in effect slammed the door on our future!"

Wray, W8GQW, points out AMSAT HF Nets will continue to play a major role in AMSAT's information dissemination system even beyond the advent of AMSAT OSCAR 10. AO-10 "Will not," he says, "eliminate the need for the HF Nets in the near future. We will be employing both resources in our quest for better communications."

Would you like to be a part of the AMSAT Net Team? If so, please contact Net Manager Wray Dudley, W8GQW, 1617 W. McKaig Rd., Troy, OH 45373 or call if you wish at 513-339-2254.

Correct AO-10 Frequencies

An unfortunate series of errors led to the publication here of incorrect frequencies for Mode L of AO-10. These errors have appeared in other newsletters since. Please help to make the *correct* frequencies widely known:

Mode B General Beacon (GB) 145.810
Engineering Beacon (EB) 145.987
Uplink 435.025 - 435.175
Downlink 145.975 - 145.825
Mode L General Beacon (GB) 436.020
Engineering Beacon (EB) 436.040
Uplink 1269.050 - 1269.850
Downlink 436.950 - 436.150

T-Shirts Proclaim "Future Now"

AMSAT's new T'shirts have arrived and are available from AMSAT HQ NOW! As the photo clearly demonstrates, the T'shirts could hardly be more timely. All the amateur world is abuzz with OSCAR 10 talk. Be the first in your club or Hamfest to show off the new OSCAR on YOUR chest. Be part of the "Future" with AMSAT's Future Now T'shirts. Help celebrate the great launch and the great AO-10 operations to come. Just $7.50 in small, medium, large and extra large. These are quality Hanes shirts in light (sky) blue with navy blue lettering. Unmatched anywhere. Suit up the whole family for Phase III now! Get'em while the supply lasts. They'll be all gone soon. Don't miss out on this collector's T'shirt. Send today. Just $7.50 to AMSAT, P.O. Box 27, Washington, DC 20044. Specify quantity, size. Visa/Mastercard OK. Do it today!

AMSAT Membership Drive Offers New Rig

AMSAT has announced a six-month membership drive that offers major incentives to AMSAT members who bring in the most new members. Structured as a contest, the first place winner will receive a super OSCAR satellite rig, the Yaesu FT-726R. The new FT-726R is unique in that it allows Mode B and Mode A operation with a single transceiver. It operates full duplex, i.e., can transmit on one band and simultaneously receive on another. For example, configured for Mode B, the rig transmits on 70 cm and receives on 2. Similarly, for Mode A, the new FT-726R transmits on 2 and receives on 10. With all the options cranked in, the prize is worth over $1400! Consolation prizes of equipment and books shall be made to the next 10 highest finishers. Watch for details on consolation prizes. There will be a total of 11 winners in all with the top prize, the FT-726R, going to the top member recruiter.

Rules for the contest are as follows. Points are awarded for each new member signed. The schedule for award of points is one point for a regular (annual member), two points for member society and three points for a life member. The contest period commences 1 July 83 and ends 31 Dec. 83. Only AMSAT members are eligible to participate. If you yourself become a member you get a point. If you upgrade to Life Member from regular member you get three points. You may not let your annual membership lapse and then renew to count as a point.

Only entries on official AMSAT membership applications count. Locally reproduced copies of official membership applications are OK. The entry must contain the name and address of the applicant and his sponsor's name and membership number to be valid. All applications must be mailed to AMSAT, P.O. Box 27, Washington, DC 20044, postmarked not later than midnight, 31 Dec. 83.

Membership applications may be obtained in any reasonable quantity from AMSAT at the above address. Send a SASE of sufficient size and with adequate postage to accommodate the quantity you request. A book of 100 applications will cost about $1.20 to mail first class and requires an 8" x 10" envelope.

Announcement of the winners and award of the prizes will be made not later than 1 Feb. 84. Standings of contestants for comparison purposes will be announced in the AMSAT media at appropriate intervals throughout the contest period. No other inquiries shall be honored as to standings. Decision of the judges if final. In the event of a tie, a random drawing will be held. An applicant becomes a member when an application accompanied by payment in full is received. No time-payment plan applications will count for points towards the prize.

The main prize for this contest, retail value with options as offered, is at least $1400. This prize has been donated in support of AMSAT by Yaesu-Musen of California through the kindness of Mr. Chip Margelli of Yaesu.

According to AMSAT President Elect WA2LQQ, "The objective of the membership drive is to raise the membership level from its present level of about 4,000 to at least 7,777 by years end." Everyone is encouraged to take up the challenge.

ASR Announces Special AO-10 Special Edition

Amateur Satellite Report will shortly publish a special edition to help beginners and veterans alike come to know, understand and successfully use the newest OSCAR, AO-10. The Special Edition will be sent to all regular subscribers at no extra cost. Non-subscribers may obtain this Special Edition postpaid (U.S., Canada and Mexico) for $3; $4 postpaid elsewhere. If you have a friend who is just getting started, tell him about this limited time offer. The mailing address is 221 Long Swamp Road, Wolcott, CT 06716.

Heart Attack Fells WØPN

ASR has learned that a key AMSAT contributor has suffered a serious heart attack and is in the hospital at press time. Ron Dunbar, WØPN, was stricken on his way to work Wednesday, 29 June. His condition was reported to be satisfactory at press time but he will remain in the hospital for at least a week.

Ron had had a prior eposide of heart trouble just three years ago. That occasion was later diagnosed as angina, a serious condition and indicator but not a "heart attack" per se. Ron has been pressing especially hard in recent weeks to upgrade many of the features of IPS, the language used by AO-10 IHU and the Phase III GCS (Ground Command Stations). Ron's work has been essential in developing a usable product. In the five years he's been working the IPS project he has become the cornerstone of the GCS effort even traveling to West Germany to learn from the IPS author, DJ4ZC, the inner secrets of the Forth-like language.

Ron was featured recently in a profile by WØMD in *ASR* #31, April 26, 1982. AMSAT wishes Ron a speedy and total recovery. Cards and well wishes may be sent to Ron at his home at 6012 East Superior St., Duluth, MN 55804.

Orbit Predictions

By Phil Karn, KA9Q

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oscar-7:
Wed Jun 29 01:10:29 1983 UTC: Ascending node at 115.3 west
Nodal period: 114.93911 min
Longitude increment: 28.736658 deg w/orbit
Element set 480, epoch: Sun Feb 20 09:08:52 1983 UTC

oscar-8:
Wed Jun 29 00:33:13 1983 UTC: Ascending node at 92.7 west
Nodal period: 103.16687 min
Longitude increment: 25.794016 deg w/orbit
Element set 771, epoch: Sat Jun 18 23:49:52 1983 UTC

oscar-9:
Wed Jun 29 00:57:24 1983 UTC: Ascending node at 144.7 west
Nodal period: 94.65757 min
Longitude increment: 23.663052 deg w/orbit
Element set 479, epoch: Sun Jun 19 09:02:45 1983 UTC

rs-3:
Wed Jun 29 01:04:08 1983 UTC: Ascending node at 323.2 west
Nodal period: 118.51831 min
Longitude increment: 29.756414 deg w/orbit
Element set 70, epoch: Sun Jun 19 00:04:54 1983 UTC

rs-4:
Wed Jun 29 00:32:31 1983 UTC: Ascending node at 309.8 west
Nodal period: 119.39366 min
Longitude increment: 29.975353 deg w/orbit
Element set 119, epoch: Sat Jun 18 01:55:52 1983 UTC

rs-5:
Wed Jun 29 00:39:44 1983 UTC: Ascending node at 310.8 west
Nodal period: 119.55457 min
Longitude increment: 30.015718 deg w/orbit
Element set 96, epoch: Sat Jun 18 13:35:51 1983 UTC

rs-6:
Wed Jun 29 01:40:41 1983 UTC: Ascending node at 331.1 west
Nodal period: 118.71582 min
Longitude increment: 29.805828 deg w/orbit
Element set 56, epoch: Thu Jun 16 01:03:34 1983 UTC

rs-7:
Wed Jun 29 00:09:20 1983 UTC: Ascending node at 305.3 west
Nodal period: 119.19538 min
Longitude increment: 29.925806 deg w/orbit
Element set 111, epoch: Fri Jun 17 00:06:00 1983 UTC

rs-8:
Wed Jun 29 00:13:13 1983 UTC: Ascending node at 303.0 west
Nodal period: 119.76401 min
Longitude increment: 30.068065 deg w/orbit
Element set 229, epoch: Fri Jun 17 00:47:12 1983 UTC
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Satellite: rs-3
Catalog number: 12997
Epoch time:      83170.00340303
   Sun Jun 19 00:04:54 1983 UTC
Element set:          70
Inclination:       82.9594 deg
RA of node:       335.0137 deg
Eccentricity:    0.0059606
Arg of perigee:    30.6741 deg
Mean anomaly:     329.7787 deg
Mean motion:   12.15577424 rev/day
Decay rate:          4e-08 rev/day^2
Epoch rev:            6665
Semi major axis:  7987.373 km
Anom period:    118.462220 min
Apogee:           1662.320 km
Perigee:          1567.101 km
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Satellite: rs-4
Catalog number: 13000
Epoch time:      83169.08046883
   Sat Jun 18 01:55:53 1983 UTC
Element set:         119
Inclination:       82.9670 deg
RA of node:       340.8063 deg
Eccentricity:    0.0017804
Arg of perigee:   100.6324 deg
Mean anomaly:     269.6742 deg
Mean motion:   12.06666017 rev/day
Decay rate:          4e-08 rev/day^2
Epoch rev:            6605
Semi major axis:  8026.676 km
Anom period:    119.337081 min
Apogee:           1683.169 km
Perigee:          1654.588 km
```

```
Satellite: rs-5
Catalog number: 12999
Epoch time:      83169.56657294
   Sat Jun 18 13:35:52 1983 UTC
Element set:          96
Inclination:       82.9501 deg
RA of node:       341.3880 deg
Eccentricity:    0.0011285
Arg of perigee:   127.5274 deg
Mean anomaly:     232.6783 deg
Mean motion:   12.05041432 rev/day
Decay rate:          4e-08 rev/day^2
Epoch rev:            6602
Semi major axis:  8033.893 km
Anom period:    119.497966 min
Apogee:           1678.062 km
Perigee:          1659.929 km
```

```
Satellite: rs-6
Catalog number: 13002
Epoch time:       83167.04415290
   Thu Jun 16 01:03:35 1983 UTC
Element set:              56
Inclination:       82.9591 deg
RA of node:       337.8394 deg
Eccentricity:     0.0051195
Arg of perigee:    51.9598 deg
Mean anomaly:     308.6070 deg
Mean motion:   12.13555110 rev/day
Decay rate:          4e-08 rev/day^2
Epoch rev:            6618
Semi major axis:  7996.250 km
Anom period:    118.659630 min
Apogee:           1672.107 km
Perigee:          1590.234 km
```

```
Satellite: rs-7
Catalog number: 13001
Epoch time:       83168.00417604
   Fri Jun 17 00:06:01 1983 UTC
Element set:             111
Inclination:       82.9580 deg
RA of node:       340.0934 deg
Eccentricity:     0.0023051
Arg of perigee:    66.0891 deg
Mean anomaly:     294.2600 deg
Mean motion:   12.08672869 rev/day
Decay rate:          4e-08 rev/day^2
Epoch rev:            6603
Semi major axis:  8017.783 km
Anom period:    119.138936 min
Apogee:           1675.723 km
Perigee:          1638.760 km
```

```
Satellite: rs-8
Catalog number: 12998
Epoch time:       83168.03278288
   Fri Jun 17 00:47:12 1983 UTC
Element set:             229
Inclination:       82.9580 deg
RA of node:       343.3674 deg
Eccentricity:     0.0018600
Arg of perigee:   177.4323 deg
Mean anomaly:     182.6854 deg
Mean motion:   12.02934444 rev/day
Decay rate:          4e-08 rev/day^2
Epoch rev:            6572
Semi major axis:  8043.278 km
Anom period:    119.707271 min
Apogee:           1680.136 km
Perigee:          1650.215 km
```

```
Satellite: oscar-8
Catalog number: 10703
Epoch time:       83169.99296803
   Sat Jun 18 23:49:52 1983 UTC
Element set:             771
Inclination:       98.7550 deg
RA of node:       182.6066 deg
Eccentricity:     0.0006764
Arg of perigee:   333.4169 deg
Mean anomaly:      26.6636 deg
Mean motion:   13.96565652 rev/day
Decay rate:          1.59e-06 rev/day^2
Epoch rev:            26949
Semi major axis:  7281.041 km
Anom period:    103.110083 min
Apogee:           912.004 km
Perigee:          902.154 km
Translate freq:   581.0974 mhz
Invert:                 1
Beacon:           435.0965 mhz
```

```
Satellite: oscar-9
Catalog number: 12888
Epoch time:       83170.37691238
   Sun Jun 19 09:02:45 1983 UTC
Element set:             479
Inclination:       97.5461 deg
RA of node:       136.5261 deg
Eccentricity:     0.0002018
Arg of perigee:   345.9696 deg
Mean anomaly:      14.1502 deg
Mean motion:   15.22245085 rev/day
Decay rate:          4.994e-05 rev/day^2
Epoch rev:            9413
Semi major axis:  6874.176 km
Anom period:     94.597119 min
Apogee:           498.653 km
Perigee:          495.879 km
Beacon:           145.8250 mhz
```

```
Satellite: oscar-10
Catalog number: 14129
Epoch time:       83180.50000000
   Wed Jun 29 12:00:00 1983 UTC
Element set:          MH 6-28-83A
Inclination:       8.5210 deg
RA of node:       243.7810 deg
Eccentricity:     0.7286985
Arg of perigee:   188.7810 deg
Mean anomaly:     311.0310 deg
Mean motion:    2.30084130 rev/day
Decay rate:          0.000155 rev/day^2
Epoch rev:              29
Semi major axis: 24242.277 km
Anom period:    625.858029 min
Apogee:         35529.454 km
Perigee:          198.832 km
Beacon:           145.8100 mhz
```

The AMS-81 Tracking System

```
AMSAT AMS-81 TRACKING SYSTEM
TRACKING FROM 03JUN83 121500
   >>U0RPK        VIA P3B  INIT <<
 UTC     AZ  EL  RANGE  PHS  DOPPLER

2307:15  194  00   7785    8  145.812
2309:28  188  03   8180    9    -1.4
2311:42  184  06   8623   10    -1.6
2313:56  179  08   9101   10    -1.7
2316:50  174  10   9756   12    -1.8
2319:44  170  12  10434   13    -1.9
2323:44  165  13  11388   14    -1.9
2328:46  160  15  12585   16    -1.9
2335:17  155  17  14104   19    -1.9
2344:11  150  18  16087   23    -1.8
2357:28  145  19  18818   28    -1.7
      ----04JUN83----
0021:04  140  22  23017   38    -1.4
0121:05  139  27  30753   62    -1.0
0221:06  144  32  35377   86    -0.6
0310:41  150  36  37374  106    -0.3
RET=0 CONT=1 SCROLL=2 STEP=7
```

The AMS-81 Tracking System has been designed to provide owners of the inexpensive Timex/Sinclair 1000 computer system (16K RAM) with accurate schedule and tracking information for Phase II or Phase III type orbits.

```
AMSAT AMS-81 TRACKING SYSTEM
ACCESS SKED FROM: 03JUN83 121500
   >>U0RPK        VIA P3B  INIT <<
 DAY    AOS   LOS    MAX  DX/EL   AZ

03JUN  2307  0859   0403  14543   158
04JUN  2251  0548   0108  16809   112
06JUN  0420  1353   0847  16708   247
07JUN  0103  1055   0552  14458   201
07JUN  2201  0751   0258  15077   140
08JUN  2323  0431   0004  17640   102
09JUN  0715  0925   0925  18031*  261
10JUN  0305  1248   0742  15837   235
10JUN  2354  0948   0448  14196   180
11JUN  2101  0641   0153  15813   125
12JUN  2351  0305   2351  18066*  095
13JUN  0523  1034   0932  17616   259
14JUN  0153  1142   0637  15015   221
14JUN  2247  0840   0343  14352   159
15JUN  2204  0529   0049  16625   112
RETURN = 0, CONT = 1
```

Watch for more details on this system to appear in AMSAT publications soon. Shown above are two of the many video displays which help the operator track the various operating satellites presently in orbit.

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